

What is claimed is:

1 1: A method comprising:
2 determining the configuration of a system of resources;
3 determining the processing requirements of an application running on the system
4 of resources;
5 analyzing the determined configuration and requirements in order to attempt to
6 optimize the performance of the application;
7 generating optimization suggestions from the analysis; and
8 dynamically applying the optimization suggestions.

1 2: The method of claim 1, wherein dynamically applying the optimization suggestions
2 includes:
3 dynamically allocating resources to the execution of and interaction with the
4 application; and
5 dynamically utilizing acceleration tools.

1 3: The method of claim 2, wherein dynamically utilizing acceleration tools includes
2 utilizing tools selected from a group including:
3 primitive performance libraries;
4 managed runtime optimization settings; and
5 reordering portions of application execution.

1 4: The method of claim 1, wherein determining the configuration of a system of
2 resources includes utilizing a device and environment characterization database.

1 5: The method of claim 4, wherein the device database includes information regarding
2 the types of resources in the system of resources and information regarding the physical
3 capabilities of these resources.

1 6: The method of claim 5, wherein the environment database includes information
2 regarding the configuration, substantially current status, and substantially current
3 capacity of the resources within the system of resources.

1 7: The method of claim 6, wherein device and environment characterization database is
2 incrementally generated as each of the resources of the system of resources is powered-
3 on.

1 8: The method of claim 4, wherein the device and environment characterization database
2 is dynamically generated utilizing a service including:
3 collecting data from sensors coupled with the resources;
4 analyzing the data collected;

- 5 inferring an execution context characterization;
- 6 estimating the capacity of each resource; and
- 7 updating the device and environment characterization database.

1 9: The method of claim 1, wherein determining the processing requirements of an
2 application includes utilizing an application characterization database.

1 10: The method of claim 9, wherein the application characterization database includes:
2 a static application characterization database that is capable of storing information
3 regarding fixed characteristics of the application; and
4 a dynamic application characterization database that is capable of storing information
5 regarding mutable characteristics of the application.

1 11: The method of claim 10, wherein the static application characterization database is
2 generated utilizing:
3 determining, by the application's compile time, the data types utilized by the application;
4 determining, by the application's compile time, the frequency of the usage of the data
5 types;
6 determining, by the application's compile time, the resource required by the application;
7 and
8 updating the static application characterization database with the determined information.

1 12: The method of claim 11, wherein the dynamic application characterization database
2 is generated utilizing:
3 reading the static application characterization database;
4 collecting runtime application data usage;
5 analyzing application usage and identifying resource usage bottlenecks;
6 updating the dynamic application characterization database.

1 13: The method of claim 10, further including:
2 predicting application performance after applying the suggested optimizations;
3 monitoring the actual application performance to generate empirical data;
4 comparing the actual application performance to the predicted performance;
5 performing the method of claim 1, and utilizing the empirical data when
6 analyzing the determined configuration and requirements in order to attempt to optimize
7 the performance of the application.

1 14. A system comprising:
2 a distributed application;
3 a system of resources capable of executing the distributed application;
4 a Content & Context Sensitive Accelerator capable of attempting to optimize the
5 performance of the distributed application;

6 a Device & Environment Database capable of providing information to the
7 Content & Context Sensitive Accelerator about the system of resources;
8 an Application Characterization Database capable of providing information to the
9 Content & Context Sensitive Accelerator about the distributed application; and
10 unmanaged system software capable of utilizing and the system of resources.

1 15. The system of claim 14, further including:
2 a framework library capable of providing a common set of code modules to both
3 the distributed application and the unmanaged system software, and
4 a runtime manager capable of managing the interaction between the system of
5 resources and any application executing on the system of resources; and
6 wherein the Content & Context Sensitive Accelerator is capable of attempting to optimize
7 by
8 providing a set of instructions to the runtime manager based, at least in part, upon
9 the information provided by the Device & Environment Database and the Application
10 Characterization Database; and
11 selecting which portions of the framework library will be utilized by the
12 distributed application.

1 16. The system of claim 15, further including a primitive performance library capable of
2 providing a set of code modules that are specifically optimized for a particular resource
3 architecture; and

4 wherein the Content & Context Sensitive Accelerator is further capable of attempting to
5 optimize by
6 determining that the a first portion of the distributed application is to execute
7 utilizing the framework library and a second portion is to execute utilizing the primitive
8 performance library.

1 17. The system of claim 14, wherein the Content & Context Sensitive Accelerator is.
2 capable of attempting to optimize the performance of the distributed application by:
3 determining the configuration of a system of resources utilizing the Device &
4 Environment Database;
5 determining the processing requirements of an application running on the system
6 of resources utilizing the Application Characterization Database;
7 analyzing the determined configuration and requirements in order to attempt to
8 optimize the performance of the distributed application;
9 generating optimization suggestions from the analysis; and
10 dynamically applying the optimization suggestions.

1 18. The system of claim 17, wherein the Device & Environment Database is capable of
2 being dynamically generated utilizing a service including:
3 collecting data from sensors coupled with the resources;
4 analyzing the data collected;
5 inferring an execution context characterization;

6 estimating the capacity of each resource; and
7 updating the device and environment characterization database.

1 19. The system of claim 18, wherein the Application Characterization Database includes:
2 a static application characterization database that is capable of storing information
3 regarding fixed characteristics of the distributed application; and
4 a dynamic application characterization database that is capable of storing information
5 regarding mutable characteristics of the distributed application.

1 20. The system of claim 19, wherein the static application characterization database is
2 generated utilizing:
3 determining, by the application's compile time, the data types utilized by the
4 application;
5 determining, by the application's compile time, the frequency of the usage of the
6 data types;
7 determining, by the application's compile time, the resource required by the
8 application; and
9 updating the static application characterization database with the determined
10 information.

1 21. The system of claim 20, wherein the dynamic application characterization database is
2 generated utilizing:

3 reading the static application characterization database;

4 collecting runtime application data usage;

5 analyzing application usage and identifying resource usage bottlenecks;

6 updating the dynamic application characterization database.

1 22. An apparatus comprising:

2 a Dynamic Application Optimizer capable of attempting to dynamically optimize
3 the performance of an application that is capable of being executed on a system of
4 resources;

5 a Device & Environment Database capable of providing information to the
6 Dynamic Application Optimizer about the system of resources;

7 an Application Characterization Database capable of providing information to the
8 Dynamic Application Optimizer about the distributed application; and
9 empirical data that is capable of providing feedback to the Dynamic Application

10 Optimizer about the success of the attempted optimization.

1 23. The apparatus of claim 22, wherein the Dynamic Application Optimizer is capable of:

2 determining the configuration of a system of resources utilizing the Device &
3 Environment Database;

4 determining the processing requirements of an application running on the system

5 of resources utilizing the Application Characterization Database;
6 analyzing the determined configuration and requirements in order to attempt to
7 optimize the performance of the application;
8 generating optimization suggestions from the analysis;
9 dynamically applying the optimization suggestions;
10 predicting application performance after applying the suggested optimizations;
11 monitoring the actual application performance to generate empirical data;
12 comparing the actual application performance to the predicted performance; and
13 utilizing the empirical data to attempt improve application performance.

1 24. The apparatus of claim 23, wherein the Dynamic Application Optimizer is capable of.
2 applying the optimization suggestions by:
3 dynamically allocating portions of the system of resources to the execution of and
4 interaction with the application; and
5 dynamically utilizing acceleration tools;
6 wherein the acceleration tools are selected from a group including:
7 primitive performance libraries;
8 managed runtime optimization settings; and
9 reordering portions of the application execution.

1 25. The apparatus of claim 23, wherein the Device & Environment Database includes:
2 a device portion having information regarding the types of resources in the system

3 of resources and information regarding the physical capabilities of these resources; and
4 an environment portion having information regarding the configuration,
5 substantially current status, and substantially current capacity of the resources within the
6 system of resources.

1 26: The apparatus of claim 23, wherein the Device & Environment Database is capable
2 of being dynamically generated utilizing a service including:
3 collecting data from sensors coupled with the resources;
4 analyzing the data collected;
5 inferring an execution context characterization;
6 estimating the capacity of each resource; and
7 updating the device and environment characterization database.

1 27: The apparatus of claim 26, wherein the application characterization database
2 includes:
3 a static application characterization database that is capable of storing information
4 regarding fixed characteristics of the application; and
5 a dynamic application characterization database that is capable of storing
6 information regarding mutable characteristics of the application.

1 28: The apparatus of claim 27, wherein the static application characterization database is
2 generated utilizing:

3 determining, by the application's compile time, the data types utilized by the
4 application;

5 determining, by the application's compile time, the frequency of the usage of the
6 data types;

7 determining, by the application's compile time, the resource required by the
8 application; and

9 updating the static application characterization database with the determined
10 information.

1 29: The apparatus of claim 28, wherein the dynamic application characterization
2 database is generated utilizing:

3 reading the static application characterization database;

4 collecting runtime application data usage;

5 analyzing application usage and identifying resource usage bottlenecks;

6 updating the dynamic application characterization database.

1 30: A system comprising:

2 an application;

3 a system of resources capable of executing and interacting with the application;

4 a Dynamic Application Optimizer capable of attempting to dynamically optimize

5 the performance of the application;
6 a Device & Environment Database capable of providing information to the
7 Dynamic Application Optimizer about the system of resources; and
8 an Application Characterization Database capable of providing information to the
9 Dynamic Application Optimizer about the distributed application.

1 31: The system of claim 30, wherein the Dynamic Application Optimizer is capable of:
2 determining the configuration of a system of resources utilizing the Device &
3 Environment Database;
4 determining the processing requirements of an application running on the system
5 of resources utilizing the Application Characterization Database;
6 analyzing the determined configuration and requirements in order to attempt to
7 optimize the performance of the application;
8 generating optimization suggestions from the analysis; and
9 dynamically applying the optimization suggestions.

1 32: The system of claim 31, wherein the Dynamic Application Optimizer is further
2 capable of:
3 predicting application performance after applying the suggested optimizations;
4 monitoring the actual application performance to generate empirical data;
5 comparing the actual application performance to the predicted performance; and
6 utilizing the empirical data to attempt improve application performance.

1 33: The system of claim 32, wherein the Dynamic Application Optimizer is capable of
2 applying the optimization suggestions by:
3 dynamically allocating portions of the system of resources to the execution of and
4 interaction with the application; and
5 dynamically utilizing acceleration tools;
6 wherein the acceleration tools are selected from a group including:
7 primitive performance libraries;
8 managed runtime optimization settings; and
9 reordering portions of the application execution.

1 34: The system of claim 32, wherein the Device & Environment Database includes:
2 a device portion having information regarding the types of resources in the system
3 of resources and information regarding the physical capabilities of these resources; and
4 an environment portion having information regarding the configuration,
5 substantially current status, and substantially current capacity of the resources within the
6 system of resources.

1 35: The system of claim 32, wherein the Device & Environment Database is capable of
2 being dynamically generated by:
3 collecting data from sensors coupled with the resources;

4 analyzing the data collected;
5 inferring an execution context characterization;
6 estimating the capacity of each resource; and
7 updating the device and environment characterization database.

1 36: The system of claim 35, wherein the application characterization database includes:
2 a static application characterization database that is capable of storing information
3 regarding fixed characteristics of the application; and
4 a dynamic application characterization database that is capable of storing
5 information regarding mutable characteristics of the application.

1 37: The system of claim 36, wherein the static application characterization database is
2 generated utilizing:
3 determining, by the application's compile time, the data types utilized by the
4 application;
5 determining, by the application's compile time, the frequency of the usage of the
6 data types;
7 determining, by the application's compile time, the resource required by the
8 application; and
9 updating the static application characterization database with the determined
10 information.

1 38: The system of claim 37, wherein the dynamic application characterization database is
2 generated utilizing:

3 reading the static application characterization database;

4 collecting runtime application data usage;

5 analyzing application usage and identifying resource usage bottlenecks;

6 updating the dynamic application characterization database.

1 39. The system of claim 37, wherein the system of resources includes a plurality of
2 hardware architectures; and
3 the application is a distributed application.

1 40. The system of claim 39, wherein the system of resources includes the Dynamic
2 Application Optimizer.

1 41: An article comprising:

2 a storage medium having a plurality of machine accessible instructions, wherein when the
3 instructions are executed, the instructions provide for:

4 determining the configuration of a system of resources;

5 determining the processing requirements of an application running on the system

6 of resources;
7 analyzing the determined configuration and requirements in order to attempt to
8 optimize the performance of the application;
9 generating optimization suggestions from the analysis; and
10 dynamically applying the optimization suggestions.

1 42: The article of claim 41, wherein the instructions providing for dynamically applying
2 the optimization suggestions includes instructions providing for:
3 dynamically allocating resources to the execution of and interaction with the
4 application; and
5 dynamically utilizing acceleration tools.

1 43: The article of claim 42, wherein the instructions providing for dynamically utilizing
2 acceleration tools includes instructions providing for utilizing tools selected from a group
3 including:
4 primitive performance libraries;
5 managed runtime optimization settings; and
6 reordering portions of application execution.

1 44: The article of claim 41, wherein the instructions providing for determining the
2 configuration of a system of resources includes instructions providing for utilizing a
3 device and environment characterization database.

1 45: The article of claim 44, wherein the device database includes information regarding
2 the types of resources in the system of resources and information regarding the physical
3 capabilities of these resources.

1 46: The article of claim 45, wherein the environment database includes information
2 regarding the configuration, substantially current status, and substantially current
3 capacity of the resources within the system of resources.

1 47: The article of claim 46, wherein the article includes instructions providing for
2 incrementally generating the device and environment characterization database as each of
3 the resources of the system of resources is powered-on.

1 48: The article of claim 44, wherein the instructions providing for the device and
2 environment characterization database to be dynamically generated utilizing a service
3 including instructions providing for:
4 collecting data from sensors coupled with the resources;

5 analyzing the data collected;
6 inferring an execution context characterization;
7 estimating the capacity of each resource; and
8 updating the device and environment characterization database.

1 49: The article of claim 41, wherein the instructions providing for determining the
2 processing requirements of an application includes instructions providing for utilizing an
3 application characterization database.

1 50: The article of claim 49, wherein the application characterization database includes:
2 a static application characterization database that is capable of storing information
3 regarding fixed characteristics of the application; and
4 a dynamic application characterization database that is capable of storing information
5 regarding mutable characteristics of the application.

1 51: The article of claim 50, wherein the instructions providing for the static application
2 characterization database include instructions providing for the database's generation
3 utilizing:
4 determining, by the application's compile time, the data types utilized by the application;
5 determining, by the application's compile time, the frequency of the usage of the data
6 types;

7 determining, by the application's compile time, the resource required by the application;
8 and
9 updating the static application characterization database with the determined information.

1 52: The article of claim 51, wherein the instructions providing for the dynamic
2 application characterization database include instructions providing for generating the
3 database utilizing:
4 reading the static application characterization database;
5 collecting runtime application data usage;
6 analyzing application usage and identifying resource usage bottlenecks;
7 updating the dynamic application characterization database.

1 53: The article of claim 50, further including instructions providing for:
2 predicting application performance after applying the suggested optimizations;
3 monitoring the actual application performance to generate empirical data;
4 comparing the actual application performance to the predicted performance;
5 performing the method of claim 1, and utilizing the empirical data when
6 analyzing the determined configuration and requirements in order to attempt to optimize
7 the performance of the application.

1 54: A method of reducing energy consumption comprising:
2 determining the characteristics of a system of resources that an application will
3 execute on;
4 determining the processing requirements of the application; and
5 dynamically applying a set of optimizations designed to reduce energy
6 consumption of the application.

1 55: The method of claim 54, wherein determining the characteristics of a system of
2 resources includes:
3 determining whether the system of resources is powered either by a limited or a
4 substantially unlimited power supply.

1 56: The method of claim 55, wherein a limited power supply includes a battery.

1 57: The method of claim 55, further including, if at least a portion of the system of
2 resources is powered by a limited power supply, estimating how much power remains in
3 the limited power supply.

1 58: The method of claim 54, wherein determining the characteristics of a system of
2 resources includes utilizing a device and environment characterization database; and

3 wherein determining the processing requirements of the application includes utilizing an
4 application characterization database.

1 59: The method of claim 54, wherein dynamically applying a set of optimizations
2 includes utilizing tools selected from a group including:
3 primitive performance libraries;
4 managed runtime optimization settings;
5 altering which of the resources of the system of resources executes portions of the
6 application;
7 altering which of the resources of the system of resources interacts with portions
8 of the application;
9 altering the data provided by the application;
10 altering the capabilities of the application; and
11 reordering portions of application execution.

1 60: The method of claim 59, further including:
2 predicting application power usage after applying the set of optimizations;
3 monitoring the actual application power usage;
4 monitoring the amount of available power available to the application;
5 dynamically applying a new set of optimizations if either the available power
6 changes or the actual application power usage is not within a predefined range compared
7 to the predicted application power usage.

1 61: An article comprising:
2 a machine readable medium having a plurality of machine accessible instructions,
3 wherein when the instructions are executed provide for:
4 determining the characteristics of a system of resources that an application will
5 execute on;
6 determining the processing requirements of the application; and
7 dynamically applying a set of optimizations designed to reduce energy
8 consumption of the application.

1 62: The article of claim 61, wherein the instructions providing for determining the
2 characteristics of a system of resources includes instructions providing for:
3 determining whether the system of resources is powered either by a limited or a
4 substantially unlimited power supply.

1 63: The article of claim 62, wherein a limited power supply includes a battery.

1 64: The article of claim 62, further including instructions providing for, if at least a
2 portion of the system of resources is powered by a limited power supply, estimating how
3 much power remains in the limited power supply.

1 65: The article of claim 61, wherein the instructions providing for determining the
2 characteristics of a system of resources includes instructions providing for utilizing a
3 device and environment characterization database; and
4 wherein the instructions providing for determining the processing requirements of the
5 application includes instructions providing for utilizing an application characterization
6 database.

1 66: The article of claim 61, wherein the instructions providing for dynamically applying
2 a set of optimizations includes instructions providing for utilizing tools selected from a
3 group including:
4 primitive performance libraries;
5 managed runtime optimization settings;
6 altering which of the resources of the system of resources executes portions of the
7 application;
8 altering which of the resources of the system of resources interacts with portions
9 of the application;
10 altering the data provided by the application;
11 altering the capabilities of the application; and
12 reordering portions of application execution.

- 1 67: The article of claim 66, further including instructions providing for:
 - 2 predicting application power usage after applying the set of optimizations;
 - 3 monitoring the actual application power usage;
 - 4 monitoring the amount of available power available to the application;
 - 5 dynamically applying a new set of optimizations if either the available power
 - 6 changes or the actual application power usage is not within a predefined range compared
 - 7 to the predicted application power usage.